Integrating Literature into the teaching of mathematics

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Mathematics teachers are frequently looking for real-life applications and meaningful integration of mathematics and other content areas. Many genuinely seek to reach out to students and help them make connections between the often abstract topics taught in school. In this article I share several ideas to help teachers foster student curiosity about mathematical ideas, by exploring children's literature and other fiction.

In recent years, many books have emerged which directly focus student attention to mathematical ideas. From Marilyn Burns to David Schwartz, Gregg Tang to Jon Scieszka and Lane Smith, we have seen numerous examples of outstanding direct integration of mathematics and literature. However, the questions beg: What about some of our own favorite children's and other fiction books? Are there ways to connect books that do not have obvious mathematical themes and adapt them for use in a mathematics classroom? What about, say, *Mirette on the High Wire* (McCully, 1997), or *Golly Gump Swallowed a Fly* (Cole, 1982), or maybe even a John Grisham novel? It turns out that the possibilities are endless.

Instead of searching hard for the 'right' book, it might be easier to look at any book with the 'right' intentions and just make it happen. For example, consider any book through the lense of 'obvious', 'hidden', and 'adapted' relationships between its content and possible mathematics topics. Billings and Beckmann (2005) defined these three relationships mostly in the context of the topic of functions:

1. obvious relationships arise "directly from the context of the book";
2. hidden relationships are "possible to find", but, "might be concealed within the story and not as easy to define";
3. adapted relationships are ones where, "the reader can impose a function on some aspect of the text by modifying the relationships, often in surprising ways" (p. 470).

Another possible way of integrating mathematics in a non-routine way would be through the use of Fermi problems. Named after the Noble Prize winner in physics Enrico Fermi, these problems are open-beginning and open-ended problems (Peter-Koop, 2005). Unlike the majority of traditional textbook problems, they do not include numbers and thus enable students of different grade and ability levels to address them and provide their own possible interpretation and solution, based on assumptions that they establish and data that they generate themselves, possibly using reputable sources. One of these estimation problems commonly attributed to Fermi is "How many piano tuners are there in Chicago?"

An example of a ready-to-use engaging problem in a children's book can be found in *Sylvester Bear Overslept* (Wahl, 1979). The book is about two bears who went to bed, but one of them, named Sylvester, could not fall asleep:

> They lay there counting bees making honey.
> After almost a week, Sylvester
> Counted forty thousand bees.

While this is not an example of a true Fermi problem (due to the mention of a number), a teacher can rephrase it as follows:

- "If Sylvester counted bees, how many bees would he count in one week?"
- "If Sylvester counted to forty thousand bees, how long would it take him to count this high?"

To answer the first question, let's assume that he can count to one hundred in one minute. So we would want to know how many minutes are in one week. There are 60 minutes in an hour, 24 hours in 1 day and 7 days in 1 week.

$$60 \times 24 \times 7 = 10\,080 \text{ minutes in 1 week.}$$ [1]

Another book that is likely to achieve cult classic status, similar to the one held by *The Catcher in the Rye* (1959), is the recent fiction work of Paolo Giordano, an Italian professional physicist, *The Solitude of Prime numbers* (2010). The book is summarised in the New York Times (Eder, 2010) as:

> The story of Alice, crippled as a child in a ski fall and anorexic thereafter, and Mattia, a math prodigy whose guilt over the death of his mentally backward twin sister has led him repeatedly to scar or burn himself. They meet as teenagers, each isolated among their schoolmates, and from then on are both deeply joined and unable, variously, to hold to the joining.

Mathematics makes its way into the book especially in pages 111–115, where the author Paolo Giordano reflects on the special qualities of prime numbers, and twin primes in particular. He compares Alice and Mattia to twin primes: "...pairs of prime numbers that are close to each other, almost neighbors, but between them there is always an even number that prevents them from truly touching." (p. 111)

The book offers a great introduction to prime numbers, "suspicious, solitary numbers, ... trapped like pearls on a necklace" (p. 111) which can be followed up with questions such as:

- "Is 1 prime, composite, neither or both? What about 2?"
- "Can we determine if there are infinitely many primes?"
- "Are there infinitely many twin primes?" (Twin-prime conjecture).
- "What is a semi-prime?"
- "What are Fermat, and Mersenne primes?"
- "What is GIMPS, and why is it important?"
  (Caldwell, 1999-2016)

Another rather unlikely book for prompting mathematical thinking and engaging in some meaningful investigations is John Grisham's *The Summons* (2002). This book captures the story of two brothers, Ray and Forrest, who discover that their father, Judge Atlee, has died somewhat unexpectedly, leaving behind a large sum of money. The money, in $100 notes, is initially stashed in 27 stationery boxes. A significant portion of the book is about Ray trying to secretly count the money and move it to different hiding places as he deliberates how his father amassed so much.

Below are included some possible mathematics questions that relate to the above scenario:

- If the money is initially in 27 stationary boxes, and is in bands of $100 dollar bills, how much money did Ray find, if there were 53 bands in each box?

1. Additional related ideas can be found at the following website:http://www.bigsiteofamazingfacts.com/how-long-does-it-take-to-count-to-1-million (Hill, 2007).

The stationery boxes are 12 inches across, 18 inches high, and 5 inches deep. A dollar note is about 6.125 inches by 2.625 inches, and is 0.0043 inches thick (Fact Monster, 2000–2013). About 232 new notes will stack up to a height of one inch. (Information about the new $100 notes is available online through the U.S. Department of the Treasury at https://uscurrency.gov/sites/default/files/download-materials/en/--new100--100_education.pdf).

- About how much did all the money weigh? (Fact Monster, 2000–2013).
- If you were paid the minimum federal wage ($7.25 in 2015), how long would it take you to earn that amount of money? If the judge gambled three times a week for five years and won $2,000 every time, how much would he have in winnings overall? (modified from *The Summons* (Grisham, 2002)).

The above ideas on integrating literature and mathematics are examples of how easily mathematics can be found in books that initially do not come across as containing mathematics content. Most students would love a good story that engages them in some meaningful, non-routine math explorations.

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